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JOINT COMMITTEE ON FINANCE

MEMORANDUM

To: Members
Joint Committee on Finance

From: Senator Howard Marklein
Representative Mark Born

Date: November 11, 2021

Re: UWS Report to JFC

Attached is the Industrial and Economic Development Funds report from the University of Wisconsin System, pursuant to s. 36.25(25)(c), Stats.

This report is being provided for your information only. No action by the Committee is required. Please feel free to contact us if you have any questions.

Attachments

HM:MB:jm

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NOV 1 1 2021
Jt. Finance

Date: November 10, 2021

To: Senator Howard L. Marklein, Co-Chair
Representative Mark Born, Co-Chair
Joint Committee on Finance

From: Tommy Thompson, President

Re: 2019-21 Report on Industrial and Economic Development Funds

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With an economic impact of over $24 billion annually, the University of Wisconsin System is continuously engaged in economic growth for the state. One of the tools the UW uses to ensure its research mission translates into economic success is the Industrial and Economic Development Research Fund (IEDRF).

The funding for this program is distributed through two channels: 1) the Applied Research Program, and 2) the Industrial and Economic Development Research/State Economic Engagement and Development (SEED) Program. These initiatives are intended to promote technology transfer and collaborative projects that stimulate economic development in Wisconsin.

Wis. Stats. s.36.25(25)(c) requires the University of Wisconsin System to report biennially to the Joint Committee on Finance regarding projects funded as part of the industrial and economic development research program in the previous fiscal biennium. The enclosed report is submitted for your review.

If you require any additional information regarding this report, please contact Deej Lundgren, Director for State Relations (dlundgren@uwsa.edu or 608-262-5450).

cc: Dave Loppnow, Assistant Director, Legislative Fiscal Bureau
Anny Morrobel-Sosa, Vice President for Academic & Student Affairs
Tracy Davidson, Director, STEM and Applied Research Initiatives

Industrial and Economic Development Research Fund
2019-2021 Biennial Report

The Industrial and Economic Development Research Fund (IEDRF) was established in 1987 to enhance the relationship between UW System institutional research and Wisconsin industrial practices in an effort to promote the state's economic growth. It has supported projects which have assisted a large number of Wisconsin enterprises. Many of these projects continue to improve the competitive position of Wisconsin businesses.

This report describes the activities supported by the IEDRF for the 2019-20 and 2020-21 fiscal years. The report is divided into two narrative sections and six appendices. The first narrative section details the Industrial and Economic Development Research Program (IEDR), which has also been referred to as the SEED (State Economic Engagement and Development) program since 2014. This program provides grants to faculty and staff at UW-Madison. The second section provides an overview of the Applied Research Program, administered by the UW System Office of Academic Affairs. These funds provide grants to faculty throughout the UW System.

Both the IEDR/SEED program and the Applied Research Program provide grants which are competitively awarded. Researchers are encouraged to submit technically innovative proposals that are of interest to a broad economic sector and will immediately benefit Wisconsin's industrial and economic development. All projects are selected based on a combination of scientific merit and the potential for technology transfer. Grant summaries are provided in the appropriate sections.

Six appendices are attached which list all grants, investigators, campuses or departments, and the amounts funded by the IEDR/SEED and Applied Research programs.

A. Industrial and Economic Development Research (IEDR) and State Economic Engagement and Development (SEED) Program – UW-Madison

The Office of the Vice Chancellor for Research and Graduate Education administers the IEDR/SEED program for the University of Wisconsin-Madison. The IEDR/SEED program seeks to stimulate and enhance research collaborations between UW-Madison and Wisconsin firms and to promote economic development in the state. University faculty and staff researchers submit proposals that are subject to a competitive selection process. A selection panel composed of past entrepreneurs, representatives from technology transfer, and business development experts select technically innovative projects that will benefit Wisconsin businesses. The panel reviews each proposal for scientific and technical merit, while also taking into consideration the impact the research will have on the identified sector of the Wisconsin economy. Applicants for this program must have a financial or management interest in a company that has spun out of research performed at UW-Madison.

The IEDR/SEED program funded six projects during the fiscal year ending June 30, 2020 ($570,875) and six projects during the fiscal year ending June 30, 2021 ($600,000).

COVID-19 had a significant impact on projects awarded in both fiscal years. Some challenges included the inability to work in labs and the need to limit the number of people in a lab at one time, being unable to hire lab workers and graduate students, and the inability to purchase necessary supplies. As a result, 12-month research deadlines for many projects needed to be extended and four projects have had their deadlines stretched to December 31, 2021 to allow them time to complete their research goals. Those four projects have submitted an interim report and will complete a final report at the end of their extension.

Research titles for individual projects are listed in this report. The following points highlight some noteworthy facts and outcomes resulting from IEDR/SEED research program:

- Over the 2019-2021 biennium, IEDR/SEED funding supported a broad range of collaborative research between UW-Madison scientists and Wisconsin businesses.

- Faculty indicated that IEDR/SEED funding fundamentally demonstrates state and university commitment to translational research, solidifies research collaborations with companies, and leverages awards into further funding opportunities. Several faculty members noted the scarcity of such funding to directly support product development, making it unlikely that the research would have been undertaken without support from IEDR/SEED. Some specific feedback received includes:

    - In providing funding for a key set of experiments which successfully demonstrated insulin production and potential for control of diabetes after transplantation of RMS's islet-like clusters into diabetic mouse models, the SEED funding was essential for supporting these initial pilot, in vivo efficacy studies. In addition to establishing RMS stem cell product therapeutic efficacy in rodent diabetes, these pilot results also established the value for using this unique diabetic mouse model for preclinical efficacy assessments. (Dr. Jon Odorico)
    - We appreciate the VCRGE support to this project. If we did not receive the support we would not have been able to get the funding for the BOTTLE, SBIR and venture funding. (Dr. George Huber)
    - VCRGE funding has been instrumental in driving this research forward and getting us to a point where we are becoming competitive for external funding. (Dr. Andreas Velten)
    - The SEED program provided the gap funding to support the application testing and validation of this technology for commercial use. This led to acquiring our first paying customers and raising $2.3M in seed financing. (Dr. Faraz Choudhury)
    - The support of the VCRGE was very critical to develop the QAC/Wx technology and testing for both animal (Infectious bronchitis virus) and human (SARS-Cov-2) vaccines. (Dr. Adel Talaat)
    - Thanks to this funding, we were able to hire postdocs with the particular metabolomic expertise needed to help advance the discovery by refining methods that allow us to prioritize which isolates are more likely to produce antimicrobial compounds that have previously been uncharacterized, thereby honing the drug discovery pipeline. The funding also supported the purchase of an essential piece of equipment (HPLC) to help isolate molecules of interest from crude extracts. (Dr. Jo Handelsman)
    - VCRGE funding was critical to advancing the development of our liquid biopsy system, and played a major role in preparing a proposal by Capio Biosciences to the NSF SBIR program. (Dr. Seungpyo Hong)

- VCRGE support and funding of this project has proven to be very valuable for developing the syringe adapter product. The funds have supported development and testing of many iterations of design, with each iteration serving to reduce risk of commercializing the ErgoExact-50 at scale. The developments made, and those continued through Fall 2021 will prepare the company for additional angel or VC investment to manufacture and deliver the ErgoExact-50, as well as to apply for an SBIR grant in January 2021 to expand research into additional syringe sizes. (Dr. Robert Radwin)

- Data from IEDR/SEED projects allowed several faculty to apply for and receive large research grants directly from federal agencies and subcontracts with partnering companies, who received SBIR grants.

- As a result of IEDR/SEED research, some collaborating companies will achieve cost savings, plan to hire additional staff, or are in better positions to manufacture and market their products. This provides an economic boost directly to the State of Wisconsin.

- In addition to faculty and academic staff, several graduate and undergradaute students, as well as postdoctoral fellows worked on these projects. Many of these trainees received training for high-tech jobs and left UW-Madison with job offers in technology companies.

- Researchers have already submitted or published 10 research papers in peer-reviewed journals and conference proceedings. Additional papers are either in progress or planned.

B. Ignite Grant Program (formerly known as the Applied Research Programs – ARG, AR-WiTAG, and PDF)

The University of Wisconsin System, in collaboration with WiSys, annually offers competitive funding for applied research projects to UW System faculty and academic staff. This funding, formerly administered as the UW System Applied Research Grant (ARG), Applied Research-WiSys Technology Advancement Grant (AR-WiTAG), and Prototype Development Fund (PDF) programs, has been consolidated under the Ignite Grant Program to simplify the terminology and streamline administration.

The Ignite Grant Program supports the development of advanced human potential and the knowledge economy that employs that potential. In particular, the Ignite Program for Applied Research and the Ignite Program for Prototype Development help to promote technology transfer and economic development throughout Wisconsin and provide for broader impact beyond the state. WiSys Technology Foundation (WiSys), a 501 (c)(3) supporting organization of the UW System, administers this grant program on behalf of UW System. UW System makes final decisions on grant funding.

Applied research activities strengthen the connection between knowledge and practice while promoting positive change in the state's economy. Potential benefits of these activities include fostering business expansion and improving profitability, creating jobs and enhancing workforce quality, reducing costs and increasing efficiency, and improving the quality of Wisconsin's products and services. The purpose of the Ignite Program for Prototype Development is to provide financial assistance for supporting research and development intended to advance the commercial potential of technologies developed through the UW System and assigned to WiSys.

The Ignite Program for Applied Research is competitive. Principal investigators from UW System institutions submit proposals documenting their realizable applied research goals and objectives, a detailed work plan, and funding requirements to achieve outcomes that may result in societal and/or economic impact to the state including intellectual property protection, technology transfer, business expansion and profitability, and job creation. A panel composed of representatives from the private sector with expertise in business and technology, a representative from WiSys, and a representative from UW System reviewed and rated proposals.

For the 2019-20 and 2020-21 programs, 75 applications were received with requests for more than $3.5 million in funding. Twenty-three (23) awards were made over the two fiscal year cycles including 22 Ignite applied research grants, and one Ignite prototype development grant (Figure 1). A total of $1,067,091 was awarded to institutions across the UW System, with 19 of 23 awards going to four-year comprehensive universities.

Specifically, in 2020-21, the Ignite Grant Program for Applied Research received 37 applications for funding, requesting a total of $1,793,769. Eleven (11) Ignite applied research grants were funded by UW System in the total amount of $515,000.

In 2019-20, the Ignite grant programs received 38 applications for funding, requesting a total of $1,778,133.

Eleven (11) Ignite applied research grants were funded by UW System in the total amount of $537,091. UW System provided further funding to support one (1) Ignite prototype development grant totaling $15,000. In addition, UW System provided WiSys a stipend of $66,211 to cover patenting and licensing costs for technologies developed with the support of the Ignite grant programs.

As a result of the coronavirus pandemic, award recipients for the 2019-20 Ignite grant program were provided no-cost extensions through December 31, 2020. Additional extensions have been granted for select projects due to the ongoing disruptions and limited access to laboratory spaces at UW campuses. As such, reported outcomes for this grant cycle are limited. Also, in the context of limitations imposed by the pandemic, award recipients for the 2020-21 Ignite grant program were provided no-cost extensions through December 31, 2021.

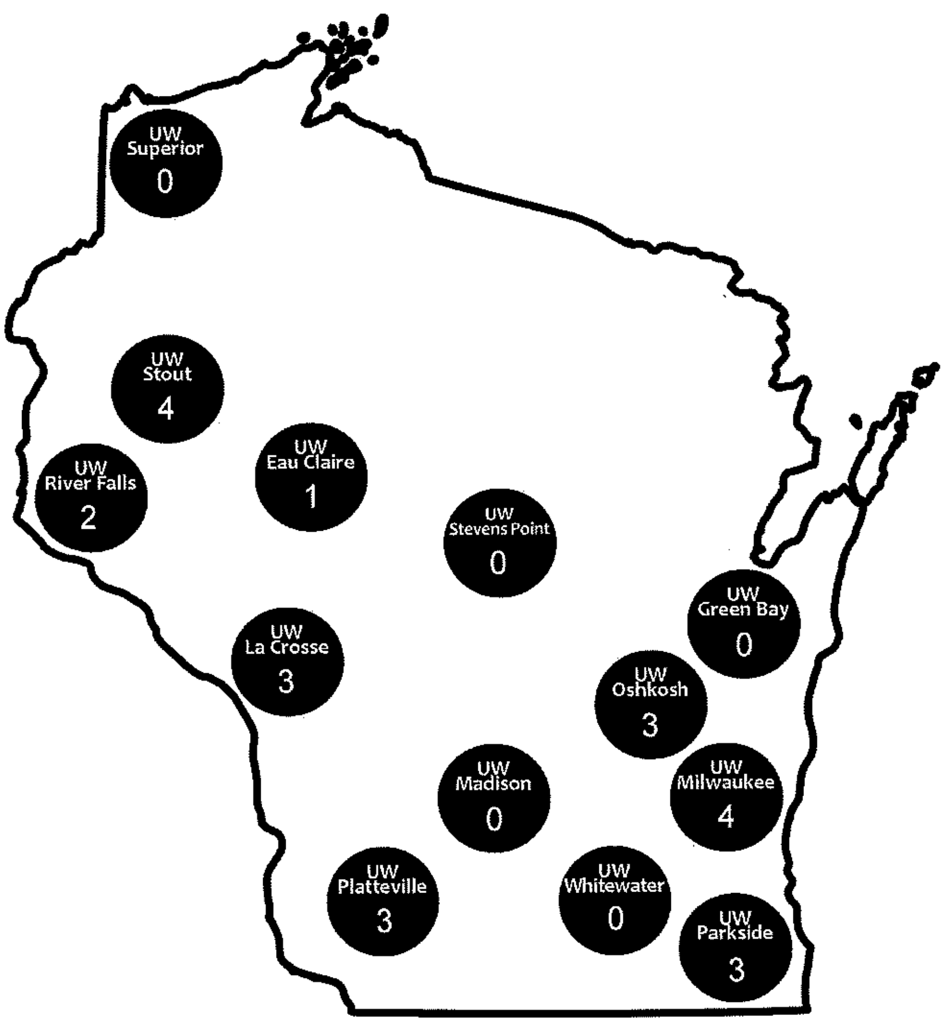

Figure 1. 2019-20 and 2020-21 Ignite projects funded by campus

While outcomes from the 2020-21 program will be finalized in the coming year, the above funding from the 2019-20 Ignite grant program cycle has resulted in the following outcomes to date, with additional outcomes anticipated as extended project periods are completed:

- Three invention disclosures, and two U.S. patent applications;
- Three scientific publications in peer reviewed journals;
- Job creation, providing support to 14 undergraduate students (1,788 hours), one post-doctoral associate, eight months of summer salary, and 7 credit release hours for faculty ($82,460); and
- Submission of further applied research grants for follow-on funding from these agencies/programs: NSF- CBET program; DoD – Basic Energy Sciences (Materials) and DoD – Strategic Environmental Research and Development Program (SERDP); NSF MRI program; and Spencer Research Grants on Education. $337,000 in funding was awarded by the NIH to UW-River Fall's faculty, Dr. Matthew O'Reilly, for his work on the development of novel emmacin analogues as potential new antibiotics.

Ignite Applied Research Awards, Fiscal Year 2020-21

See Appendix E for a list of investigators, institutions, project titles, and amounts of the awards.

1. Nanoparticle- and Biotin-Based Probes for Inclusion in a Citrulline Detection Kit,
(PI: Jennifer Grant, UW-Stout)

    Citrullination is a post-translational modification of proteins that is the root cause of multiple sclerosis and rheumatoid arthritis; recently it has been correlated with chronic periodontitis. Increasingly, evidence that citrullination may impact a variety of neurological disorders, cancer, and immunity in general is being published. Despite the medical relevance of citrullination, however, there exist only a limited number of methods for identifying citrullinated proteins and the precise site of modification. Previous work has led to the development of citrulline-reactive probes utilizing reactive heads based on a 1,3-dicarbonyl moiety which is more stable, easier to handle, and easier to synthesize compared to the phenylglyoxal moiety used in all currently available citrullination probes. In addition, the probes are designed in a modular fashion where both the citrulline-responsive reactive head and the detection tag are built separately. The proposed work aims to further advance this technology to provide for a robust method to detect and isolate full-length proteins utilizing a variety of detection tags (biotin and superparamagnetic nanoparticles).

2. Genetic Analysis of Nitro Algae: A New Algal Strain with Improved Biomass Yield on Reduced Nitrogen,
(PI: David Higgs, UW-Parkside)

    Nitrogen is critical for the growth of algae and plants, and it is the most limiting nutrient for growth of food crops, with a high financial and environmental cost. New and alternative ways are needed to reduce nitrogen fertilizer use with crop plants (for food) and projected industrial algae (for biofuels), while maintaining high growth and yield in both. The research group from UW-Parkside has identified and characterized a new strain of the green alga *Chlamydomonas reinhardtii* termed NitroAlgae. This strain grows better, ~55% higher biomass, than wild-type algae in low nitrogen and with ~28% higher biomass than WT grown in standard high nitrogen. The main goal of this project is to identify the genetic change(s) that affect gene expression and alter nitrogen metabolism, allowing NitroAlgae to grow better in low nitrogen. Future work would then transfer the genetic changes to industrial algae and, potentially, crop plants such as corn. The long-term goal is to significantly reduce nitrogen fertilizer used to grow algae and crop plants, if the mechanism is transferrable, while maintaining normal algal biomass and plant yield. This would have significant benefits to the reduction in cost and input resources (nitrogen), while benefiting the environment through decreased nitrogen runoff into lakes and rivers and reducing energy and input costs.

3. Generation of Carotenoids for Animal Feed and Pigmentation,
(PI: Francis Mann, UW-Parkside)

    Carotenoid natural products are currently a $1.4 billion market, with the vast majority of applications in the food and feed industries. The ketocarotenoid astaxanthin is a red pigment especially valuable to the aquaculture industry, as supplementation of farmed fish is required for proper pigmentation.

Astaxanthin can be produced synthetically, but natural availability is limited. Demand for naturally sourced astaxanthin increased 760% from 2007-2016, but current methods of production have severe limitations. In this proposal, three novel methods for meeting the demand of naturally sourced red carotenoid pigments are presented. The first method proposes to evaluate two novel red carotenoid pigments for use in aquaculture; the second and third method propose unique mechanisms by which fermentative production of astaxanthin may be increased. All three methods represent viable options for alleviating pressure on the natural carotenoid market and may be applied individually or in pairs to increase pigment production.

4. Versatile Low-Cost Iron-based Systems for Green Catalytic Desulfurization,
   (PI: Robert McGaff, UW-La Crosse)

   Among the many classes of harmful chemical compounds generated by human activity including commercial/industrial manufacturing processes, transportation, fuels production and other sources, sulfur-containing compounds give rise to some of the most pressing remediation concerns, from both the economic and environmental/ecological standpoints. Many concerns derive from the unpleasant odors and toxicity associated with specific compounds of sulfur: hydrogen sulfide (H2S) and mercaptans. These compounds are released both in aqueous waste streams and in the gas phase during manufacturing processes (such as of paper products), sewage treatment activities and biodigestion among other sources. These same deleterious sulfur-containing compounds can occur naturally in crude oil and gas, along with other contaminants including dibenzothiophene (DBT) and related compounds. This research project is aimed at discovery and development of new catalytic desulfurization technologies with end uses in oil and gas sweetening and treatment of waste effluents (both aqueous and gas phase). The proposed experiments have been designed around the oxidative desulfurization (ODS) strategy applied to mercaptans and dibenzothiophene (and related compounds) with emphasis placed on use of environmentally-friendly, iron-based catalysts and oxidants, optimal performance in terms of sulfur compound removal from relevant matrices, and minimized costs of production and use wherever possible. The project focuses on simplification of the synthesis and optimization of performance of lead catalysts; preparation, development and testing of two new heterogeneous catalytic systems for ODS with a primary focus on minimizing costs of production through the use of very inexpensive supports; and characterization, optimized synthesis, and testing as an ODS catalyst of a material we first synthesized recently.

5. Protecting Vegetable Crops using Bioactive Enzymes Targeting Bacterial Communication,
   (PI: Sabrina Mueller-Spitz, UW Oshkosh)

   Wisconsin consistently ranks 4th in the US for cucumber production and 3rd for potato production annually. The potato crop in Wisconsin was valued at $340m in 2016 (8.5% of US total) while the cucumber crop was valued at $12.9m in 2019 (3.9% of US total). A 5% increase in these values due to more effective crop protection would be a gain of $17.6m annually. Agricultural crops can be negatively impacted by bacteria during growth and during harvest/storage. These bacteria use chemical communication to cause damage to the crop including the damage known as soft rot. The proposed project aims to demonstrate whether the native enzymes produced are effective at degrading the bacterial communication molecules in vivo. The team have previously demonstrated that several enzymes act as lactonases (ring-opening) for homoserine lactones (HSL – common bacterial communication molecules) in vitro. The proposed project will treat cultures of soft rot pathogen (SRP) bacteria with the enzymes and attempt to detect intact HSLs. The team will then treat potato slices with the SRP bacteria and the enzymes to determine if SRP process is interrupted or retarded based on gene expression. Once validated, this enzyme product has the potential to be used to reduce the incidence of soft rot in stored potatoes and bacterial wilt in cucumbers.

6. <u>A New Design Of Lithium Ion Battery With Improved Energy Density For Electronic Devices and Cordless Power Tools,</u>
   (PI: Junjie Niu, UW-Milwaukee)

   The increasing carbon emission in our environment from traditional energy sources such as fossil fuels due to the expanding energy request has become a global issue. This directs researchers to seek environmentally friendly energy storage with greatly improved energy density and low cost that can meet the requirement for large portable devices particularly electric vehicles (EVs). The worldwide battery market in 2016 is 65 billion US$ (pack level). The rechargeable battery market worldwide in 2025 can reach 610 GWH by CAGR. In Wisconsin, there are a large amount of battery manufacturers such as Johnson Controls Inc. (JCI, Milwaukee, now Clarios), Optima Batteries Inc. (Milwaukee), Storage Battery Systems, Inc. (Menomonee Falls), Rayovac (Middleton), BAE Batteries USA (Somerset) and C & D Technologies, Inc. (Milwaukee). The state also houses battery customers for various portable devices and cordless power tools such as Milwaukee Tool (Brookfield). The proposed project aims to develop a new lithium ion battery (LIB) system that can deliver 25% battery performance improvement contrasted to conventional graphite-based LIBs along with the clean-energy training on STEM students for potential engineers. The major goal is to achieve a greatly improved battery performance surpassing graphite-NMC LIBs without increasing the complexity and overall cost.

7. <u>Flow Energy Harvesting with Piezoelectric Beams,</u>
   (PI: Edoardo Rubino, UW-Platteville)

   According to the U.S. Department of Energy, the annual power production from renewable sources in Wisconsin is 1.4 Giga Watt. In addition, the U.S. Energy Information Administration states that 1/3 of this production comes from wind, namely from wind energy farms with 433 wind turbines installed. It can be estimated that the operation and maintenance cost of a wind turbine is approximately 48000$/MW. Assuming that half of the power that comes from wind in Wisconsin would be produced by using the proposed device, a maintenance cost reduction of ~$1.1M could be obtained. The use of piezoelectric energy harvester in replacement of solar panels would boost the use of renewable energy sources with a positive impact on the economy of the State. This research project aims to optimize the performances of a device for flow energy harvesting. The device is based on the functioning principle of piezoelectric smart materials: they can indeed generate a voltage if deformed. In this case, the deformation will be induced by the incoming flow on a cantilever piezoelectric beam. The addition of 3D-printed components can significantly increase the performances of the device without influencing its cost. A randomly shaped post placed in front of the beam increases the level of turbulence in the flow and therefore the voltage produced by the cantilever beam. Preliminary results show that a voltage up to three times higher can be obtained with the post. However, due to the aleatory nature of the physics involved in the problem, more experiments are necessary to fully understand the behavior of the system. The focus of this project is to design, build and test novel configurations of piezoelectric beams to optimize the power output while reducing the cost of production.

8. A Strategic Framework for Wisconsin's Paper Industry: Growing, Innovating, and Sustaining, (PI: Jeffrey Sachse, UW Oshkosh)

   Wisconsin's pulp, paper and converting industries generated $18.16 billion in economic output and employed 30,262 workers in 2018. Collectively, the paper industry is the fifth-largest manufacturing sector in Wisconsin. Wisconsin's paper industry is significant not only within the state: It leads the nation by many metrics, including in value of products sold, number of employees and number of paper mills. Many of the industry characteristics and strategies addressed within this project, including human capital management and sustainability, are typically the domain of a single firm rather than an industry consortium. The adoption of a strategic development process that prioritizes stakeholder engagement encourages sharing challenges and success. It thereby increases the likelihood of success of organizations like the Wisconsin Paper Council through the identification of agreed upon goals and commitment of resources. The project will utilize a collaboration with the Wisconsin Paper Council to develop a ten-year strategic framework for Wisconsin's pulp, paper, and converting industry. The industry was the focus of a 2019 analysis by the Wisconsin Institute for Sustainable Technology and is one of the state's strongest legacy industries. The strategic framework will build upon this earlier work by providing the Council and its member companies with a tactical roadmap to face the significant talent, innovation, and sustainability challenges in its future.

9. Identifying the Lethal Factor Protein Induced by SK-03-92 Treatment in Staphylococcus aureus, (PI: William Schwan, UW-La Crosse)

   In the United States, nearly 700,000 hospitalizations are reported each year due to *Staphylococcus aureus*. Costs for S. aureus-associated skin infections are close to $5 billion, or an average of $11,622 per patient. Approximately two-thirds of the S. aureus strains isolated from patients are methicillin-resistant (MRSA), causing 278,000 infections and 19,000 deaths annually. While several newer anti-MRSA drugs are currently on the market (linezolid, daptomycin, tigecycline, ceftaroline, and dalbavancin), and several other drugs moving through the development pipeline, S. aureus still develops drug resistance to all of them and the drugs may not offer any advantages over vancomycin. The proposed project aims to further the development of a new drug that has demonstrated no drug resistance and possesses a different mode of action against S. aureus that could garner substantial sales. The proposed project would identify the mechanism of action which would further the industry attractiveness of the technology for commercialization.

10. Encouraging Empathetic Communication in Electronic Messaging Services to Improve Project Outcomes from Collaborative, Cross-Disciplinary Teams, (PI: Joshua Seaver, UW-Stout)

Often, the informal quality, lack of standards, and speed at which messages can be sent in text-based media can lead to misinterpretation and tension between sender and receiver. This can result in disengagement and a lessening of project efficacy and outcomes. Group-based environments often lack indicators of feelings, and a lack of visual and auditory cues. When these cues are missing, online group members may feel a lack of belongingness and trust within their online team. Furthermore, the lack of empathic communication transferred (and received) through these electronic mediums can blossom into a highly toxic online culture with tangible, negative economic impacts. This project seeks to explore the problems of missing contextualization and lack of empathy while using electronic text communication in team-based contexts, leading to reduced productivity, and to remedy these issues by introducing structured models of compassionate communication into exchanges using a web-based plugin. The research team posits that by training students in person to use structured models of compassionate communication to express observations, feelings, needs and requests and then applying these models through electronic coaching via a plugin, collaborative teams will have greater empathy, clearer communication, and achieve greater productivity and arrive at better project outcomes.

11. Mobile Design Box Retrofit: Addressing Urban Vacancy Through Entrepreneurial Infrastructure, (PI: Alexander Timmer, UW-Milwaukee)

While Marcus & Millicap have noted that "Milwaukee enters 2019 on a high note, having witnessed robust retailer demand over the past four years that translated to the absorption of 7.4 million square feet of space." this optimism around low vacancy rates does not extend into the peripheral communities around downtown Milwaukee or the entrepreneurial community. These underserved neighborhoods are being left behind, given the growth that we see in other areas of the city. The goal of this project is to adapt Milwaukee's existing social and physical infrastructure to encourage economic and social growth through the implementation of a mobile furniture system to retrofit existing vacant storefronts. This intervention will provide the necessary resources and structures that entrepreneurs in underserved communities lack. The uniqueness of this project is the flexibility of a mobile retrofit-system of furniture that can be moved from one location to another. The mobile furniture will respond to various programming needs of small business startups such as farmer's markets attached to local urban gardens, maker spaces for local artists, and cowork and community programming. Faculty and students from the Department of Architecture will work with local communities to design and fabricate a series of mobile, interchangeable and durable furniture for these empty storefronts. Researchers will engage the users and community stakeholders through surveys to collect data and feedback on the system to track economic performance and determine the effectiveness of this system. The results of this work and the plans of the furniture will be collected and distributed through an online database, which will spur further deployment of the system beyond its original iteration.

Ignite Applied Research Awards, Fiscal Year 2019-20
See Appendix F for a list of investigators, institutions, project titles, and amounts of the awards.

1. Producing Polymer-Quantum Dot Composite Materials Through Direct Ligand Reaction,
   (PI: Samuel Alvarado, UW-River Falls)

   The global market for quantum dot nanomaterials is rapidly expanding at a 29.9% compound annual growth rate from 2013 – 2020. The largest portion of this growth is driven by the incorporation of quantum dots in flat panel displays, which provide better color definition and higher efficiency than rival technologies. Quantum dots are incorporated into displays as polymer films, but current production methods lack a high degree of control over quantum dot placement inside of the film. This proposal describes an emerging method of composite material production that chemically links together surfactants (or ligands) that are already present on the nanoparticles after synthesis. This new method can reduce fabrication complexity and provides greater control over the distance between quantum dots in a polymer film made of the surfactants. It also provides for a method of incorporating less-toxic nanomaterials into polymer films for device (solar cell, LED) fabrication. Synthesis and initial characterization will take place on the UW-River Falls campus with work conducted by students. Further material evaluation will be conducted by the PI and his students at the UW-Eau Claire Materials Characterization Center.

   Over the course of this project, the project team were able to make progress towards all objectives. Specifically, toward the preparation and characterization of new terminal alkene surfactants and the synthesis of the $(ZnS)_{34}$, the amine ligands of $(ZnS)_{34}$ were found to decompose the ruthenium catalyst used for linking nanoparticle surfactants together. As a result, the team changed the core material to silver, but the synthesis of silver nanoparticles was found to destroy the double bonds of the alkene surfactants. Finally, the team switched to Cu_2S nanoparticles, but this required the use of two different surfactants (the target alkene and an auxiliary thiol) during synthesis making it challenging to know how much active (alkene) ligand is on the nanoparticle surface. In addition, olefin metathesis reactions were conducted on $(ZnS)_{34}$ and Cu_2S nanoparticles. The low solubility of Cu_2S meant it was difficult to see whether any alkene had reacted by 1H NMR spectroscopy. TEM images before and after metathesis showed no significant difference in inter-particle spacing which was discouraging. During the COVID-19 shutdowns the team were also able to conduct a brief computational study to estimate distance between nanoparticles after successful olefin metathesis cross-linking of undecenoic acid. These results showed an expected distance decrease of 0.4 nm. This will help guide further analysis of TEM data in the future. The project supported 588 hours of undergraduate training for two students and resulted in the filing of one provisional patent application. The PI has also submitted a follow-on grant to the NSF MRI program.

2. Nanofabrication of YBa2Cu3O7 (YBCO) Based Superconductor (S)-Insulator (I)-Superconductor (S) Tunneling Sandwich-type Josephson Junction,
   (PI: Hom Kandel, UW-Parkside and Chang-Beom Eom, UW-Madison)

   Josephson junctions are used in superconductor quantum interference device (SQUID) bio-magnetometer sensors, qubits, rapid single flux quantum (RSFQ) circuits, and terahertz frequency detectors for a wide range of applications including Magnetocardiography (MCG) & Magnetoencephalography (MEG), Quantum Computing, Geophysical Measurements, and NASA & Military/Defense applications. High-Tc superconductor such as the YBa2Cu3O7 (YBCO) based

Josephson junctions offer many advantages over the conventional low Tc-based Josephson junctions with the opportunity of low-cost production, cryogenic system simplicity, and higher IcRn product (with Ic the junction critical current and Rn the normal resistance). This proposal focuses on the nanofabrication and study of sandwich-type (110)-oriented YBCO/ PrBa2(Cu0.8Ga.2)3O7 /YBCO Josephson junction device. The success of this project will pave the way for the development of S-I-S junction based high Tc -SQUID bio-magnetometers to replace the currently commercialized low Tc-SQUID bio-magnetometers based MCG/MEG systems and MRI systems used in hospitals and clinics that use liquid helium as coolant. It will help to eliminate the dependency on very expensive and increasingly unreliable liquid helium supplies as the coolant.

3. DAGIStRII: Decrease the Achievement Gap and Increase Student Retention Through Intercultural Innovation,
   (PI: Elena Marshall, UW-Stout)

   This project aims to improve retention rates and reduce achievement gaps in higher education through instructor professional development methods that improve retention in industry and student outcomes in K-12 educational settings, especially for students from first-generation, low income, and underrepresented groups. Student outcomes will be measured via registration data. Student researchers will be involved in data analysis and in dissemination, which advances high-impact practices, student employment, and workforce preparation. Intercultural agility will be measured by Intercultural Development Inventory (IDI) scores and the AACU's Intercultural Knowledge Rubric. The project supports economic development with cost-effective practices that can increase retention, improve students' economic outlook, drive down recruiting costs, and enhance Wisconsin's workforce with additional, more diverse, college-educated personnel. Piloted at UW-Stout, a 4-year public polytechnic with a 98.2% placement rate, results will increase the number of workforce-ready graduates in STEAM fields (Science, Technology, Engineering, A1i and Design, and Mathematics) through the application of Intercultural Universal Design. This methodology can be infused into all courses and benefits all students, even as it specifically strengthens support for marginalized students and employees. It also can work beyond educational environments, to improve employee retention and increase market share.

   The DAGIStRII research explored two factors that affect college student retention: instructor intercultural professional development (IPD), and instructor demographics. The research measured retention across the grant's one-year timeframe. More students of instructors who received IPD were retained than those for the control group (75% vs. 72%). An analysis of 2009-2016 UW-Stout data suggests that students of color (SoC) having an instructor of color (IoC) during their first semester at college increases the graduation rate and reduces the graduation gap by 16%, even though having a IoC increases White students' graduation rates too. All objectives were achieved.

   Specifically, the Intercultural Development Inventory (IDI) and the AACU's Intercultural Valid Assessment of Learning in Undergraduate Education (VALUE) rubric were administered as pre-and post-tests to assess change in instructors' intercultural agility. With both instruments, the average scores for the intervention group increased; for the control group averages, the IDI score was unchanged and the VALUE score decreased. In comparison with control group instructors' students, more students of intervention group instructors passed the class and more were retained Fall 2019 to Fall 2020, 75% versus 72%. After 5 years, a consistent 3% increase in retention would translate into an $1,000,000+ increase in university funding annually. Across 8 years, SoC who had an IoC during their first semester had 2.0% higher graduation rates, decreasing the graduation gap by 16%, even as

White students with an IoC during their first semester also had higher graduation rates (2.75%). Because the project's data trajectory was interrupted by the COVID pandemic, which affected retention rates, to generate generalizable data, additional research in the post-pandemic "new normal" is needed. Also, the project uncovered some of the challenges of doing research on Equity, Diversity, and Inclusion (EDI) in a collegiate environment. For example, the instructors in the control group significantly changed their grading patterns in a way that the intervention-group instructors did not. The study was not designed to take into account a significant change in the control group instructors' behavior. Additional research is needed to understand the causation. The project supported 100 hours of undergraduate training for three students and the PI has plans to submit a follow-on grant to the Spencer Research Grants on Education program.

4. Olfactory-Based Pest Control of the Colorado Potato Beetle,
   (PI: Robert Mitchell, UW Oshkosh and Sean Schoville, UW-Madison)

   The proposed project aims to utilize the use of odor sources as a novel mode of action to improve the management of the Colorado potato beetle (CPB) a major agricultural pest of potato in the US and abroad. Potatoes are a $4 billion industry in the United States and the fourth most valuable agricultural commodity in Wisconsin, with a production value of over $300 million from 68,000 planted acres of farmland. Consequently, the insect pests of potato have potential to cause significant economic damage in the state. One of the most important pests of potato is the CPB, *Leptinotarsa decemlineata*, which can defoliate entire potato fields when left uncontrolled. Infestations of CPB are usually treated by applying insecticides, but the species has rapidly developed resistance (e.g., 3), such that populations are now resistant to all classes of insecticides. This project aims to develop a method to rapidly screen chemical compounds in order to identify novel attractants and repellents. The team's research will result in a set of odorant receptor (OR) genes that are important to the behavior of CPB and for which the team have identified potential activating odorants, providing immediate and long-term applied prospects. In the short term, any compounds associated with the ORs may see immediate field trials as potential methods of control. In the long term, the team aims to develop a high-throughput platform to screen novel compounds by expressing these ORs in cell systems. Compounds developed from those assays may function as 1) attractants, directing beetles to traps; 2) behavioral inhibitors, disrupting behavior in fields; or 3) repellants, reducing the population that enters fields. Furthermore, any compounds or blends of compounds for further product development by companies specializing in agriculture or chemical manufacturing.

5. Discovery of Emmacin Related Dihydropyrimidine Analogs as Dihydrofolate Reductase Inhibitors with Narrow and Broad-Spectrum Antibiotic Activity,
   (PI: Matthew O'Reilly, UW-River Falls)

   Infectious disease remains the second leading cause of death worldwide and third in the United States. This is largely due to antibiotic resistant bacteria. The development of new antimicrobials is necessary to combat this threat, and the folate synthesis pathway is an underexploited antibiotic target. Trimethoprim (TMP) is the only widely used antibiotic that targets dihydrofolate reductase (DHFR), but resistance to TMP is growing more widespread, requiring the discovery of new chemical entities to target this enzyme. TMP is a competitive DHFR inhibitor, and various groups have synthesized TMP analogs that also inhibit through a competitive mechanism. As bacteria have acquired TMP resistance, it is likely that resistance to TMP derivatives could be acquired in an analogous fashion. It would be useful, therefore, to have DHFR inhibitors that act through a distinct, secondary mechanism. Emmacin, a compound unrelated to TMP, was discovered in 2008, and was found to inhibit DHFR via a noncompetitive mechanism. The PI's lab has synthesized emmacin derivatives to examine the structure activity relationships (SAR), and have begun to screen the compounds for biological activity. Under this project the team aim to (i) synthesize focused libraries of emmacin derivatives with structural modifications to the functionalized dihydropyrimidine structure, (ii) screen the compounds in phenotypic assays to explore each compounds' (a) spectrum of bacterial cytotoxicity and (b) any potential mammalian toxicity, and (iii) utilize biochemical assays to characterize the compounds' unique noncompetitive mechanism of action.

Over the course of this project, a series of 48 emmacin analogs were synthesized and tested for antibacterial activity against Methicillin Resistant *Staphylococcus aureus*. Growth inhibition was compared to five known antibiotics including Vancomycin, Gentamicin, Carbenicillin, Erythromycin and Trimethoprim. SAR studies yielded a select number of potent compounds for further evaluation. Toxicity studies were carried out in partnership with the Wenthur laboratory at UW-Madison to examine mammalian toxicity of the compounds against HEK-293 cell line. Preliminary data suggests some compounds may be acting via a non-specific toxicity mechanism and further experiments are warranted to further evaluate the growth inhibition mechanism. This project yielded one new invention disclosure and a provisional patent filing. The project also supported 400 hours of undergraduate training for three students and the primary investigator was successful in leveraging $337,000 in follow-on funding from an NIH AREA R15 grant.

6. <u>Towards the Commercialization of PLA/Organosolv Lignin Filament for 3D Printing,</u>
(PI: John Obielodan, UW-Platteville)

The depletion of fossil fuel resources, alarming rising levels of atmospheric CO2, and environmental pollution caused by non-biodegradable petroleum-based polymers and their threats to aquatic and human life has triggered global concerns and interests in the development of environmentally benign biobased polymers. The increasing adoption of polymer-based 3D printing has brought the convenience of fabricating solid objects to a greater proportion of the population. Many printed parts are used only once, and there are many waste disposals that result from each use. Fabrications now takes place in the homes; in educational institutions from K-12 to the universities; and in virtually all companies involved in product development. Studies have shown that petroleum-based polymers used for fused filament fabrication (FFF) 3D printing, of which acrylonitrile butadiene styrene (ABS) predominates, emits significant ultra-fine particles (UFPs) containing dangerous organic volatiles that can cause respiratory problems and cancer. The same studies show that PLA and PLA matrix materials emit significantly less UFPs. The proposed project aims to develop a proprietary formulation and process to blend two bio-based resources, polylactic acid (PLA) and organosolv lignin (lignin), to product polymeric filaments for 3D printing applications. This formulation is anticipated to be able to replace non-biodegradable ABS.

7. <u>Efficient Low-Cost Solar Water Heater Panel,</u>
(PI: Kim Pierson, UW-Eau Claire)

Heating water accounts for 25% of the energy used on a dairy farm. Wisconsin lost 20% of its dairy farms in the past 5 years (mostly small family farms) due to declining profitability. This project is directed toward developing a low-cost solar water heater panel that would be used in conjunction with a heat pump to increase the efficiency of heating buildings or creating hot water for commercial or industrial processes such as those on Wisconsin's dairy farms. The proposed technology is designed to create a large volume of warm water which is fed into a heat pump to create a smaller volume of hot water at the desired temperature. Heat pumps are 2 to 3 times more efficient as a natural gas furnace or gas water heater. The team aims to construct a next generation prototype of the panel and perform tests to determine how it performs under real weather conditions. The team will set up the prototype system to augment the heating of one of Facilities Management's maintenance shops at UW-Eau Claire. The team will attach a variety of sensors to monitor the performance of the system in the field. The proposed system is envisioned to be used to pre-heat water going into an existing water heating system via inexpensive heat exchangers reducing costs for commercial and industrial users. The panels could also be coupled to a water source heat pump water which is the most efficient method to heat water or heat buildings and homes. Every degree increase of the inlet water temperature produces a 4% increase in water source heat pump efficiency. As stated above, ¼ of the energy consumed on dairy farms is used to heat water. Dairy farms usually have some large open spaces that could be used to install large banks of panels to store warm water in insulated tanks so they will be the first commercial users to be targeted. For all applications photovoltaic panels could also be added to the solar water heater panel arrays to power the water pumps, further reducing costs.

8. Electro-Synthesis of Platform Chemicals via Catalytic Coupling of Carbon Dioxide and Alkenes, (PI: Sujat Sen, UW-La Crosse)

   The rapidly decreasing cost of renewable electricity coupled with growing global concern of climate change is motivating the decarbonization and electrification of the world's industries. Industrial processes are a significant source of carbon dioxide (ca. 5 billion metric tons by the U.S. in 20181d) and using these streams as a feedstock to produce more complex chemicals could reduce emissions both directly and indirectly via displacement of petroleum. Toward this goal, the proposed project aims to investigate the electrocarboxylation (EC) reaction and develop catalysts for the coupling of carbon dioxide (CO2) with an organic precursor to form value-added chemicals. Specifically, this project aimed to explore the coupling reaction between carbon dioxide (CO2) and activated alkenes for which nano-sized catalysts are required. Synthesizing such nano- sized catalysts deposited on the surface of complex gas-diffusion layer substrates was explored through pulsed electrodeposition methods. Metals such as nickel, zinc, their alloys were explored herein, as well as a variety of non-aqueous solvents and reactor configurations to optimize kinetics of the process, which is currently the biggest bottleneck for realization of this technology beyond the lab scale.

   The primary investigator (PI) was successful in demonstrating the fabrication of nano-structured nickel or zinc particles of varying sizes (<500 nanometers) on the surface of complex substrates such as gas-diffusion layers (GDL) using pulsed electrodeposition protocols. The electrodeposition of zinc was investigated in greater detail given the successful catalytic tests using the same. By controlling the peak pulse current density, duty cycle and charge, the team was able to demonstrate an excellent control over crystal faceting of the deposit, which has been known to affect reactivity towards CO2 coupling. Similar trends were also observed for nickel deposits, but not investigated further due to difficulty in reproducing the catalytic results. The PI was also able to successfully demonstrate the use of GDL-based reactors for the electrocarboxylation of ethylene in a W-cell configuration that uses zinc and nickel-based cathodes in a non-aqueous propylene carbonate-based electrolyte media, albeit with low faradaic yields. Additional limitations of mass transfer continue to hamper the observed rates and yields, requiring a more detailed understanding of gas-diffusion layers, and how they can be better engineered for non-aqueous systems. The third objective which focused on demonstrating the potential for the catalysts and reactor combined to afford high performance for the electrocarboxylation of ethylene was initiated but there was limited progress due to COVID-19 restrictions. Continued efforts to the same effect are ongoing at this time. This project yielded one new invention disclosure and three publications. The project also supported 700 hours of undergraduate training for five students. The PI has plans to apply for follow-on funding through the NSF's CBET program and the DoD's Basic Energy Sciences program for Materials.

9. Development of Natural and Safe Pesticides as Novel Alternatives for Sustainable Plant Disease Management,
   (PI: Muthu Venkateshwaran, UW-Platteville)

   Fungal and bacterial pathogens are one of the major causes of yield reduction in crops. As such, fungicides and bactericides are routinely used to alleviate those pests to increase crop yield. However, the current cadre of agrochemicals used to combat fungal and bacterial pathogens are rather toxic and has resulted in the degradation of our environment. One of the main goals of sustainable agriculture is to reduce the use of toxic agrochemicals, which can be done by co-opting the natural pesticides produced by various plants. One such class of compounds are the plant-derived essential oils, which is a class of volatile organic compounds produced by many plants for defense against various pests. Because these essential oils are a complex mixture of compounds and are volatile, their production and application in traditional agriculture are problematic.

   As such, this proposal looks to identify the active components of these essential oils to develop derivatives (conjugates of sugar/amino acids) to produce novel compounds (Modified Essential Oils, MEOs) that have enhanced antimicrobial activities against bacterial and fungal pathogens, have increased water solubility, higher permeability through plant membranes, lower volatility to make applications easier, and are safer to both farmers and the environment. Specifically, the project aims to investigate the efficacy of MEOs in the control of two fungal diseases (sclerotinia stem rot and brown stem rot of soybean) and a bacterial disease (bacterial blight of soybean), three major soybean diseases of Wisconsin. It is anticipated that these novel plant-derived antimicrobial compounds will have great commercial interest as botanical pesticides as they can be made available to growers for application under garden/field conditions to defend against invading pathogens. These materials will have the potential to replace or augment currently used fungicides/bactericides in plant disease management.

10. Development of Tailored Adsorbents for the Removal of Per- and Polyfluoroalkyl Substances,
    (PI: Yin Wang, UW-Milwaukee)

    Per- and polyfluoroalkyl substances (PFAS) are a class of emerging contaminants that are widely observed in natural and engineered aquatic systems. Removal of PFAS represents a special challenge for water/wastewater treatment due to their unique chemical/physical properties such as strong stability of C-F bond, high water solubility, and varied structure and carbon chain lengths. This project aimed to develop, characterize, and evaluate the performance of a class of new organic-inorganic hybrid materials to remove the recalcitrant and emerging PFAS waterborne pollutants through adsorption.

    Over the course of the project, the team successfully synthesized a suite of silica-based organic-inorganic hybrid materials modified with varied types of amine groups and/or a secondary functional group. Additionally, the team prepared functionalized adsorbents using clay but not silica as the substrate. The inclusion of this class of materials allowed for the elucidation of the importance of the inorganic substate on the material performance for PFAS removal. The key physicochemical properties of the materials were determined using different characterization technologies. The team went on to investigate the effect of material composition and property on the adsorption of PFAS. It was found that functionalized silica sorbents with bridged secondary amine groups showed substantially improved stability and performance for PFAS adsorption, compared to sorbents modified with various primary amines.

Additionally, PFAS adsorption kinetics and capacities strongly depended on property parameters of the sorbents that include surface area, porosity, and surface charge. The performance of the optimal adsorbent was evaluated in for the treatment of multiple PFAS. The adsorbent showed efficient removal of various PFAS structures, including perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), under different water chemistry conditions. This project supported one undergraduate student and one post-doctoral associate along with 0.5 months summer salary for the PI. The PI has applied for follow-on funding through the DoD's Strategic Environmental Research and Development Program (SERDP).

11. <u>Developing a New Two-Line Male Sterility System for Sorghum Hybrid Breeding,</u>
    (PI: Dazhong Dave Zhao, UW-Milwaukee)

    Sorghum is the fifth most important grain crop in the world. Moreover, sorghum has emerged as a dedicated bioenergy feedstock for sugar, biomass, and biofuel production. The market value of sorghum is 15.53 billion USD in 2015 and is projected to 26.57 billion USD in 2017, making the U.S. the largest producer of sorghum in the world. However, compared with maize and rice, the lack of a widely applicable hybrid breeding system cannot meet rapidly increasing demands for sorghum production, because the current hybrid breeding system is not able to breed all types of hybrids for increasing yield, preventing devastating diseases, and producing bioenergy.

    Recently, the PI has found an easily recognizable sorghum male sterile mutant, MS8. The team have been successful at cloning the MS8 gene, the first gene that is identified to control male sterility in sorghum. Therefore, taking advantage of the MS8 mutant and the MS8 gene, this project aims to develop a new two-line male sterility system for breeding sorghum hybrids via bioengineering approaches. The novelty of this system is that at a low cost it can be used to make various sorghum hybrids, including those important for biofuel production. Furthermore, the proposed system can be extended to other crops, which will extensively improve hybrid breeding in all crops.

<u>Ignite Prototype Development Awards, Fiscal Year 2019-2020</u>

See Appendix F for a list of investigators, institutions, project titles, and amounts of the awards.

1. <u>Preparing the CRISPR/Cas9 In Vitro Kit for Commercialization,</u>
   (PI: Tiffany Hoage, UW-Stout)

   CRISPR (clustered regularly interspaced short palindromic repeats) is a family of DNA sequences found within the genomes of prokaryotic organisms such as bacteria and archaea that are known to play a key role in the antiviral defense system of prokaryotes. The CRISPR-associated protein 9 (Cas9), is an enzyme that uses guide RNA (gRNA) to guide itself to the right part of the genome (e.g. the target sequence of DNA), it then binds to the target sequence and acts as a pair of 'molecular scissors' to cut the two strands of DNA at the designated location. When cut, the cell in question naturally tries to repair the damage and this mechanism involving the DNA's repair machinery is what enables scientists to edit genes by removing, adding or altering sections of the DNA sequence. As such, the CRIPSR/Cas9 technology has potential for a wide variety of applications in basic biological research as well as development of biotechnology products and treatment of disease. It is therefore critical that students are taught CRISPR/Cas9 techniques so that they are better prepared for the workforce in this field.

While there are limited numbers of DIY CRISPR educational kits on the market that demonstrate the power of the technology, there does not seem to be any complete kits and none allow students to make gRNAs and perform in vitro nuclease assays, the latter of which is thought to be one of the competitive advantages of this technology. The PI has developed a kit, instructional booklet and accompanying protocols for use in the classroom. The kit includes reagents and materials (including those necessary for making gRNAs) to conduct the nuclease assay. Specifically, it includes enough reagents and materials for six groups of students to make the Target DNA and gRNA, cut the Target DNA with Cas9 guided by gRNA, and visualize the uncut and cut Target DAN on an agarose gel. To date, the PI has tested the kit's protocols and is currently developing curriculum and extension activities to accompany five weeks of hands-on activities. The proposed project aims to generate a set of prototype kits for testing by colleagues in higher education.

Appendix A

Industrial & Economic Development Research Program/SEED (IEDR/SEED) Grants

2019-2020

Investigator	**Department**	**Amount**	**Researcher Company**	**Title**
David Beebe	Pathology & Laboratory Medicine	$65,262	Turba, Monona, WI	*Polymicrobial Antibiotic Susceptibility Test Assay (PASTA)*
Faraz Choudhury	Biotechnology Center	$ 132,575	Immuto Scientific, Madison, WI	*Plasma-Induced Modification to Biomolecules*
George Huber	Chemical and Biological Engineering	$78,020	Pyran, Madison, WI	*1,5-Pentanediol: A New Bio-based Monomer for the Coatings Industry*
Jon Odorico	Surgery	$70,558	Regenerative Medical Solutions, Madison, WI	*Reversal of Diabetes in Mice by Human Pluripotent Stem Cell Beta Cells*
Robert Radwin	Industrial Engineering	$97,401	KineVid, Waunakee, WI	*Computer Vision Technology to Automatically Measure, Quantify and Identify Risk for Occupational Back Injuries*
Adel Talaat	Pathobiological Sciences	$127,059	Pan Genome Systems, Madison, WI	*A novel adjuvant system for animal and human vaccines*

Appendix B

Industrial & Economic Development Research Program/SEED (IEDR)/(SEED) Grants

2020-2021

Investigator	Department	Amount	Researcher Company	Title
David Beebe	Pathology & Laboratory Medicine	$99,519	Salus Discovery, Madison, WI	*Patient-specific in vitro models to predict immunotherapy response*
Jo Handelsman	Wisconsin Institute for Discovery	$120,004	Wacasa, Madison, WI	*Tiny Earth to Market: Toward Commercialization of New Antibiotics*
Seungpyo Hong	Pharmaceutical Sciences	$87,997	Capio Biosciences, Madison, WI	*Development of a cancer exosome biomarker using a nanoengineered liquid biopsy & Capio Biosciences, Inc.*
Robert Radwin	Industrial and Systems Engineering	$75,000	Güd Medical, Madison, WI	*Development, Evaluation, Demonstration and Implementation of a Syringe Adapter in a Compound Pharmacy/ Güd Medical*
Adel Talaat	Pathobiological Sciences	$136,060	Pan Genome Systems, Inc, Madison, WI	*A Universal Vaccine Against Mycobacterial Infections*
Andreas Velten	Biostatistics and Medical Informatics	$81,420	OnLume, Inc, Madison, WI	*Mesoscale fluorescence lifetime imaging of cancer*

Appendix C

IEDR Research Projects, University of Wisconsin-Madison

2019-2020

1. Polymicrobial Antibiotic Susceptibility Test Assay (PASTA) (PI: David Beebe, Pathology & Laboratory Medicine Department), Industrial Partner: Turba , Monona, Wisconsin.
2. Plasma-Induced Modification to Biomolecules (PI: Faraz Choudhury, Biotechnology Center Department), Industrial Partner: Immuto Scientific, Madison, Wisconsin.
3. 1,5-Pentanediol: A New Bio-based Monomer for the Coatings Industry (PI: George Huber, Chemical and Biological Engineering Department), Industrial Partner: Pyran, Madison, Wisconsin.
4. Reversal of Diabetes in Mice by Human Pluripotent Stem Cell Beta Cells (PI: Jon Odorico, Surgery Department), Industrial Partner: Regenerative Medical Solutions, Madison, Wisconsin.
5. Computer Vision Technology to Automatically Measure, Quantify and Identify Risk for Occupational Back Injuries (PI: Robert Radwin, Industrial Engineering Department), Industrial Partner: KineVid, Waunakee, Wisconsin.
6. A novel adjuvant system for animal and human vaccines (PI: Adel Talaat, Pathobiological Sciences Department), Industrial Partner: Pan Genome Systems Madison, Wisconsin.

Appendix D

SEED Research Projects, University of Wisconsin-Madison

2020-2021

1. Patient-specific in vitro models to predict immunotherapy response (PI: David Beebe, Pathology & Laboratory Medicine Department). Industrial Partner: Salus Discovery, Madison, Wisconsin.
2. Tiny Earth to Market: Toward Commercialization of New Antibiotics (PI: Jo Handelsman, Wisconsin Institute for Discovery Department). Industrial Partner: Wacasa, Madison, Wisconsin.
3. Development of a cancer exosome biomarker using a nanoengineered liquid biopsy & Capio Biosciences, Inc. (PI: Seungpyo Hong, Pharmaceutical Sciences Department). Industrial Partner: Capio Biosciences, Madison, Wisconsin.
4. Development, Evaluation, Demonstration and Implementation of a Syringe Adapter in a Compound Pharmacy/ Güd Medical (PI: Robert Radwin, Industrial and Systems Engineering Department). Industrial Partner: Güd Medical, Madison, Wisconsin.
5. A Universal Vaccine Against Mycobacterial Infections (PI: Adel Talaat, Pathobiological Sciences Department). Industrial Partner: Pan Genome Systems, Inc, Madison, Wisconsin.
6. Mesoscale fluorescence lifetime imaging of cancer (PI: Andreas Velten, Biostatistics and Medical Informatics Department) Industrial Partner: OnLume, Inc, Madison, Wisconsin.

Appendix E

Ignite Grant Program Awards

2020-21

Ignite Applied Research			
Investigator	**Institution**	**Amount**	**Title**
Jennifer Grant	UW-Stout	$49,080	*Nanoparticle- and Biotin-Based Probes for Inclusion in a Citrulline Detection Kit*
David Higgs	UW-Parkside	$39,658	*Genetic Analysis of Nitro Algae: A New Algal Strain with Improved Biomass Yield on Reduced Nitrogen*
Francis Mann	UW-Parkside	$49,676	*Generation of Carotenoids for Animal Feed and Pigmentation*
Robert McGaff	UW-La Crosse	$50,000	*Versatile Low-cost Iron-Based Systems for Green Catalytic Desulfurization*
Sabrina Mueller-Spitz	UW Oshkosh	$34,058	*Protecting Vegetable Crops Using Bioactive Enzymes Targeting Bacterial Communication*
Junjie Niu	UW-Milwaukee	$48,000	*A New Design Of Lithium Ion Battery With Improved Energy Density For Electronic Devices And Cordless Power Tools*
Edoardo Rubino	UW-Platteville	$50,000	*Flow Energy Harvesting with Piezoelectric Beams*
Jeffrey Sachse	UW Oshkosh	$49,020	*A Strategic Framework for Wisconsin's Paper Industry: Growing, Innovating, and Sustaining*
William Schwan	UW-La Crosse	$45,508	*Identifying the Lethal Factor Protein Induced by SK-03-92 Treatment in Staphylococcus aureus*
Joshua Seaver	UW-Stout	$50,000	*Encouraging Empathetic Communication in Electronic Messaging Services to Improve Project Outcomes from Collaborative, Cross-Disciplinary Teams*
Alexander Timmer	UW-Milwaukee	$50,000	*Mobile Design Box Retrofit: Addressing Urban Vacancy through Entrepreneurial Infrastructure*
GRAND TOTAL		**$ 515,000**	

Appendix F

Ignite Grant Program Awards

2019-20

Ignite Applied Research			
Investigator	**Institution**	**Amount**	**Title**
Samuel Alvarado	UW-River Falls	$49,994	*Producing Polymer-Quantum Dot Composite Materials Through Direct Ligand Reaction*
Hom Kandel Chang-Beom Eom	UW-Parkside UW-Madison	$50,000	*Nanofabrication of YBa2Cu3O7 (YBCO) Based Superconductor (S)-Insulator (I)-Superconductor (S) Tunneling Sandwich-type Josephson Junction*
Elena Marshall	UW-Stout	$44,222	*DAGIStRII: Decrease the Achievement Gap and Increase Student Retention Through Intercultural Innovation*
Robert Mitchell Sean Schoville	UW Oshkosh UW-Madison	$49,907	*Olfactory-Based Pest Control of the Colorado Potato Beetle*
Matthew O'Reilly	UW-River Falls	$46,891	*Discovery of Emmacin Related Dihydropyrimidine Analogs as Dihydrofolate Reductase Inhibitors with Narrow and Broad-spectrum Antibiotic Activity*
John Obielodan	UW-Platteville	$50,000	*Towards the Commercialization of PLA/organosolv Lignin Filament for 3D Printing*
Kim Pierson	UW-Eau Claire	$49,814	*Efficient Low-Cost Solar Water Heater Panel*
Sujat Sen	UW-La Crosse	$50,000	*Electro-synthesis of Platform Chemicals via Catalytic Coupling of Carbon Dioxide and Alkenes*
Muthu Venkateshwaran	UW-Platteville	$46,263	*Development of Natural and Safe Pesticides as Novel Alternatives for Sustainable Plant Disease Management*
Yin Wang	UW-Milwaukee	$50,000	*Development of Tailored Adsorbents for the Removal of Per- and Polyfluoroalkyl Substances*

Dazhong Dave Zhao	UW-Milwaukee	$50,000	*Developing a New Two-Line Male Sterility System for Sorghum Hybrid Breeding*
Prototype Development Fund (PDF)			
Investigator	**Institution**	**Amount**	**Title**
Tiffany Hoage	UW-Stout	$15,000	*Preparing the CRISPR/Cas9 In Vitro Kit for Production*
GRAND TOTAL		**$552,091**	